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THE MUSKINGUM WATERSHED CONSERVANCY DISTRICT

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The Muskingum Watershed Conservancy District is an important example of co-operation for resources conservation by the Federal Government, a State, and the people of a local political subdivision. The Muskingum Watershed, a part of the Mississippi Drainage Basin, is the largest in Ohio, including 8,038 square miles. This area, together with the 289 square miles drained by Duck Creek, constitutes about one-fifth of the area of the state. Physiographically, it lies mostly in the unglaciated Appalachian Plateau, the northern and western part, however, being within the glaciated portion. (Plate I.) Politically, the Conservancy District consists of eighteen counties forming a political subdivision whose boundaries follow roughly those of the drainage basin.

From an economic and social point of view, this Conservancy District, created June 3, 1933, under the Conservancy Act of Ohio, passed soon after the great flood of 1913,[1] includes approximately half the major land-use problem areas of the State.[2] This very hilly section of Ohio was the first settled, but contains large areas not well adapted to arable farming on account of the difficulty of using modern farm machinery, the serious erosion due to the rapid run-off from long denuded slopes and the impoverished soils mostly of sandstone and shale origin.

The average yearly rainfall of the area is approximately 39 inches, but the run-off is high especially during the winter and

[1]Passed February 6, 1914, *Page's Annotated Ohio General Code,* Secs. 1–7994.

[2]*Major Land-Use Problem Areas and Land Utilization in Ohio.* Dept. of Rural Econ., O. S. U., and Ohio Agr. Exper. Sta. Mim. Bull. No. 79, Map, p. 2.

early spring rains, amounting to 86% for the March, 1913, storm and from 75% to 85% for that of March, 1933. Sherman's chart of mean precipitation and run-off for the years 1910–1918 shows a comparatively uniform rainfall distribution by months for the year, but a relatively high run-off from January to April with a maximum in March when the run-off was 90%.[3] The Soil Conservation Service reported a 95% run-off from plowed land in Ohio during the heavy rains of January, 1937.[4] This high run-off from steep slopes naturally increases the flood hazard.

The floods may be classed as summer floods that occur during the crop season, usually in localized areas, and winter and early spring floods which are more general and cause most of the damage. The summer rains are often heavy, but fortunately are usually localized within relatively small areas. Thus, on July 16, 1914, at Cambridge, Ohio, 7.09 inches fell in an hour and a half.[5] This remarkably intense storm was decidedly limited in area, however, decreasing rapidly in intensity in all directions until the half inch isohyet bounded it from three to five miles from the weather bureau station which just happened to be at the center of the storm.[6] Sudden and heavy summer rains are common in the Muskingum area, but being local, they are not so costly in flood totals. In fact, practically all of our major floods result from winter and spring rains, which, although perhaps of less intensity than the summer rains, may last longer and often fall on ground already wet or frozen.

At the beginning of the glacial period the surface of most of the Muskingum area had a greater relief than now; the rock floors of the pre-glacial valleys now are often buried 150 feet below the present valley bottoms.[7] The total relief of the unglaciated region, with its mature topography, however, still approximates 500 feet.[8] The surface of the old plateau, as indicated by the ridge tops, stands some 1,200 feet above the sea. The broad flat-bottomed valleys with their flood

[3]C. E. Sherman, *Ohio Stream Flow*, Part I, p. 6.

[4]C. F. Brooks and A. H. Thiessen. The Meteorology of Great Floods in the Eastern United States. *Geog. Rev.*, Apr., 1937, p. 272.

[5]W. H. Alexander, *A Climatological History of Ohio*, p. 78.

[6]C. E. Sherman, *The Ohio Water Problem*, p. 16.

[7]G. W. White. Drainage History of North-Central Ohio. *O. Jour. of Science*, Nov., 1934, p. 373.

[8]*Ibid.*, p. 367.

plains and terraces,[9] contain fertile farm lands, good roads and homes, also many towns and cities with their factories, potteries (Plate II, Fig. 2), and other industries—all hitherto subject to damage by flood.

In the March, 1913, flood, there were estimated direct damages of $13,600,000 within this District, and these were only a small part of the flood toll, with its loss of life and intangible damages of interrupted business and employment, to which should be added local, state and federal relief expenses. Counties and cities alone in the district spent over $3,000,000 to repair highways and bridges damaged by the flood of 1913. Other floods as in 1927 and 1933 added strong arguments for conservation.[10] In August, 1935, floods again ravaged the district—the damages of that month's flood within the Muskingum Basin have been estimated by engineers at $5,500,000. A suggestion of how the flood waters of that month affected business and transportation in the valleys of the District is given in Plate II, Fig. 3, which shows an urban scene where the Tuscarawas and Walhonding rivers join at Coshocton to form the Muskingum.

The difference between high and low water stages is 29 feet at Coshocton, 47.5 feet at Zanesville, 46.2 feet at McConnelsville, and 43.2 feet at Marietta. This great variation in the volume of the Muskingum is also indicated by the fact that while the average flow at its mouth is about 8,200 second-feet, the range is from a minimum of about 450 feet to a maximum of some 282,000 feet per second.[11]

The hydrographic pattern of the Muskingum Basin is such that, within a few days after heavy rains general over the drainage area, its two main branches and their wide-spreading tributaries rapidly concentrate the bulk of the run-off at Coshocton, 109 miles above the mouth of the Muskingum, and then at Dresden, where the Muskingum River, leaving the wide pre-Illinoian valley through which most of the basin above Zanesville formerly drained westward toward Newark, has cut its relatively narrow modern valley southward to Zanesville. Here, joined by the Licking and augmented by the

[9]Width, extent and character of many of these valleys may be seen clearly on the U. S. G. S. Topographic Sheets: Ohio Quadrangles of Millersburg, Uhrichsville, Coshocton, Newark, Frazeysburg and Marietta.

[10]W. T. Buckley, The Ohio River Flood of March, 1933. *O. Jour. of Sc.*, March, 1933, p. 67.

[11]C. E. Sherman, *Ohio Stream Flow*, Part I, p. 62.

waters of Wakatomika and Wills Creeks, main tributaries of the Muskingum between Coshocton and Zanesville, the Muskingum enters a still narrower gorge in which flood waters have risen higher above low water mark than in any other valley within the state. On March 28, 1913, for example, the flood water rose 44.8 feet above low water mark at Lock 10 at Zanesville.[12]

As a comprehensive program of flood control and water conservation, the Muskingum Watershed Conservancy District is developing a system involving a large key reservoir on each of the two main branches of the Muskingum, together with a dozen more on their tributary streams. (Plate I.) The plan is to have as nearly as practical, equal distribution throughout the basin of both water conservation and flood control. The project will control some two-thirds of the Walhonding and Tuscarawas drainage areas and five-sevenths of the whole Muskingum basin above Zanesville. These reservoirs, at maximum flood elevation, include 77,730 acres, of which 65% was flooded in 1913. The project is designed to protect against a storm 36% greater than that of 1913. That is, ten inches of rainfall in five days, in all parts of the basin above Zanesville, with a run-off of 90% or nine inches. This control would be sufficient to lower the flood crest below that of 1913 by 6.3 feet at Marietta, 10.6 feet at Coshocton, and 15.3 feet at Zanesville.[13] The 1913 storm was used as a basis for calculations because it was the greatest storm and flood of record in the Muskingum Basin. At that time, the heaviest rainfall was in the northern part of the Basin, extending from Bangorville (10.56 in.) to Akron (9.85 in.).[14]

Four reservoirs are provided for the Walhonding Basin, the Key reservoir, the Mohawk, fifteen miles northwest of Coshocton on the Walhonding River, having its dam where the valley narrows between a terrace on the south side and a steep cliff

[12]C. E. Sherman, *Ohio Stream Flow,* Part I, pp. 58 and 98.
R. E. Lamborn, The Newark Drainage System in Knox, Licking and Northern Fairfield Counties, *O. Jour. of Sc.*, 32: 449 (1932).
Wilbur Stout and G. F. Lamb, Physiographic Features of Southeastern Ohio, *O. Jour.* of *Sc.* 38: 71–77 (1938).
See also Zanesville, Philo, McConnelsville and Caldwell (Ohio) Quadrangles.

[13]Official Plan for the Muskingum Watershed. Conservancy District. (Revised June 5, 1935), Vol. I, p. 21.

[14]For figures and maps of the March, 1913, rainfall and flood in the Muskingum Valley, see A. H. Horton and H. J. Jackson, The Ohio River Flood of March-April, 1913. U. S. G. S. Water Supply Paper No. 334. Also, C. E. Sherman, *Ohio Water Problem,* p. 9 et seq.

on the other.[15] This dam will not form a permanent lake, its entire storage capacity of 7,950 acres being designed for flood control alone. In the January, 1937, flood, this dam, incompleted and with gates not closed, created a lake 39 feet deep. The river at normal times will flow through two large outlet tunnels through this dam, one of which penetrates the cliff of sandstone and interstratified sandstone and shale, which constitute the Mississippian formations occurring in the western third of the watershed. In the eastern two-thirds of the Muskingum basin these formations are overlaid with the Pennsylvanian formations, which average 1,100 feet in thickness. (Geol. Survey of Ohio, 4th Series, Bull. 26, p. 104.)

The Mohawk Dam is 111 feet high and 2,330 feet long. It is of earth and rock fill and is estimated to cost $2,292,763. A view from its down-stream side shows the river emerging from the twin tunnels. (Plate II, Fig. 4.) This dam was completed during the summer and fall of 1937. If the reservoir, in times of flood, is ever filled to capacity, which may never happen, it can overflow through the spillway in a saddle just to the right (north) of the cliff, which is joined to the upland by a narrow ridge.

Each dam of the Muskingum Project is provided with such an overflow spillway, and wherever possible these are located in saddles isolated from the main dam as illustrated in Fig. 5 of Plate II for the Clendening Dam. One of the outlet tunnels for the Clendening reservoir penetrates this same cliff. These outlets are constructed so as to take care of maximum capacity required under minimum head and have more than one opening as may be seen at the Wills Creek Dam. (Plate III, Fig. 6.) On the down-stream side the concrete outlet widens into a stilling basin, constructed to slow down the rushing flood waters. How this operates is apparent from the photo taken at the Mohicanville Dam January 27, 1927. (Plate III, Fig. 7.) The outlet openings, stilling basin, and spillways of the Charles Mill Dam, the first one completed, may be seen in the view looking upstream (Fig. 11). As a result of this dam some of the valley land above will be flooded by a permanent lake of 1,350 acres. A photograph taken from this dam, January 27, 1937 (Fig. 8), shows this reservoir about 6 feet deeper than the permanent lake planned. During the January, 1937, flood,

[15]Brinkhaven Quadrangle.

even the gates of the completed dams could not be closed because not all of the reservoir land had yet been purchased and (Fig. 12) vast volumes of the flood water rushed through with the "jump" intended by the construction of the stilling basin. All but three of the reservoirs were to have permanent lakes, varying in size from 350 to 3,550 acres. These were to be available to the public for boating, fishing and for cottage sites. Their combined shorelines total some 200 miles, or about equal to Ohio's frontage on Lake Erie. Practically all of this frontage is privately controlled. This is the case with almost all the areas around Ohio's inland lakes. Plate IV, Fig. 15, shows part of the lake at the Leesville Dam as it appeared in April, 1937, and indicates its beautiful setting. This was planned to be a permanent lake of 1,200 acres.

These lakes would occupy only the bottom parts of the reservoirs and were intended to store water for beneficial uses, the most important of which is the stream flow regulation required to provide during dry seasons the water necessary in the valleys below for domestic and industrial uses, satisfactory sanitary conditions, and maintenance of water table requirements for agriculture.

Notwithstanding the obvious advantages of these permanent lakes and their tremendous importance for water conservation and recreation, objections on the grounds of prospective taxation have arisen, particularly in Stark County. Litigation originating there has resulted in court decisions, which, unless additional funds are obtained from the State or Federal government, make improbable any immediate development of more than two or three, if any, of the proposed permanent lakes. In fact, April 29, 1938, the Director of the District announced they were restricting land purchases to the flood control program, but expressed a willingness to co-operate with any agencies interested in promoting the additional funds required for lakes and parks.

Fig. 11, Plate III, a picture of the Charles Mill Dam August, 1936, shows: the spillway, the stilling basin, and the outlets each provided with gates to maintain the water conservation level of the permanent lake, and to regulate the flow of the flood waters. Each gate is controlled from the gate house above.

Each of the fourteen dams in the District will be operated by gate keepers who will live in modern brick cottages (Fig. 10), built by the U. S. Government as part of the construction of every dam. These tenders will operate the gates during storms or drouths, in fact at all times, according to instructions from a central office of the Conservancy District. They will also keep regular rainfall records, take stream gauge readings, etc., as part of a comprehensive schedule for the entire system.

An aerial view (Fig. 13) of Charles Mill dam shows not only the farms below, but also how advantage has been taken of the narrowing of the present valley due to a terrace on the left (east) and a hill on the right connected by a saddle of glacial drift to the west wall of the preglacial valley.[16] All but two of the reservoirs occupy valleys antedating the glacial times, whose rock floors are deeply buried by glacial material or land waste, and whose dissected interfluves give irregular shape to farm lands.

The Pleasant Hill Dam on Clear Fork of the Mohican River, five miles southwest of Loudonville, has been constructed in a relatively young rock-cut gorge amidst beautiful scenery (Fig. 14). This is evidenced by the view down stream through its steep sided and heavily wooded gorge which leads toward the Mohican State Forest.[17] The co-operation of the State Forestry Department and of fish, game, and other conservation organizations of the State promises to make the recreation facilities within the Muskingum District one of its important accomplishments.

Another dam, the Atwood, has likewise been located in a young valley, on Indian Fork of Conotton Creek, but this young part of its valley is quite short, and the reservoir will be in the preglacial valley beyond.[18] This dam was completed in July, 1937.

The other narrow, steep-walled post-glacial valley being utilized for a dam is that of the Tuscarawas River, whose Key reservoir is the only one with an all concrete dam. (Fig. 9.) This, the Dover Dam, 3½ miles northeast of the city of that name is now completed and has cost $1,618,702, including a levee to protect the historic communistic village of Zoar. The permanent lake here would be the smallest of the eleven,

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[16]Perrysville Quadrangle (Ashland Co., Ohio).

[17]Clear Fork leaves its old preglacial valley some two miles above the dam site and flows south and east, probably five miles through this attractive gorge until it joins Black Fork. G. W. White, Drainage History of North Central Ohio. *O. Jour. of Sci.*, Nov., 1934, p. 379.

[18]Dover Quadrangle.

only 350 acres, but the flood reservoir capacity will be over 10,000 acres (10,100). (Plate V, Fig. 17.) Looking upstream can be seen the village of Zoarville, to be abandoned, also farms, fields, and orchards between the wood lots on the steep hillsides, the highway raised to skirt the dam on the left, and a branch of the Pennsylvania R. R. on the right. Relocating six miles of this railroad from its old route near the river's edge to a higher level is costing Uncle Sam $605,756. The seventy miles of railroad relocations in the Conservancy District are being paid for by the Federal Government, at a total cost of over $5,000,000.

(Plate V, Fig. 18.) Nine miles northwest of Dover in a mile-wide preglacial valley[19] the Beach City Dam requires a half million dollar relocation of the B. & O. R. R. from the valley to a flat surfaced terrace 30 to 35 feet high and 3,200 feet wide. Looking east and south from this dam can be seen some of the roads and fine farms to be protected below the dam.

This 4,800 feet long dam, like the Leesville Dam (Fig. 15),[20] the Senecaville Dam (Fig. 21) completed in the middle of May, 1937, in fact, like all except the Dover Dam, is of earthen construction with concrete spillways and outlets. Some rock is used for filling and, (Fig. 22) as illustrated at the Piedmont Dam, for rip-rapping the lower portion of the dam. Above this Piedmont Dam (Fig. 23), completed 1937, may be seen a portion of U. S. Highway No. 22 which would be drowned by its 2,700 acre permanent lake.[21] (Plate IV, Fig. 16.) Just below this dam can be seen nestled in the valley the village of Piedmont, which will no longer fear a flood.

At the Wills Creek Dam, too, (Plate V, Fig. 20) the highway had to be raised from the valley to the hillside on the right above the dam. At the Tappan Dam (Fig. 19), now finished, a great deal of road-filling had to be done as the new highway, State Route 250 crosses one branch of the flood reservoir. A mile above this dam the village of Tappan, entirely within the proposed lake (2,350 acres), had to be abandoned.[22] All of three villages and parts of eleven others were to be relocated or abandoned as, for example, part of Walhonding, above the

[19]Navarre Quadrangle.

[20]Scio Quadrangle (Carroll Co.).

[21]Flushing Quadrangle (Harrison Co.).

[22]Scio Quadrangle (where Willis Run enters Little Stillwater Creek).

Mohawk Dam. All such villages were given their choice of abandonment or removal to a new site.

The village of Plainfield has taken the latter choice. (Fig. 25.) Situated in a bend of Wills Creek, nearly all of the century-old town, except the school house, is below the maximum level of the flood-control reservoir. A new site above this level was purchased by the District and laid off into lots, with new streets, commons, and parks, to which the houses, stores, churches, etc., of the residents will be moved during the summer of 1938. In May, 1937, it was announced that many of the residents of Sandyville had agreed to removal and that bids would be received at the Muskingum Watershed Conservancy District's offices in New Philadelphia up to June 16 for moving the greater part of the village by December 1 to a new site half a mile northeast.[23] The remainder of the village is to be protected by a levee, as the present site will be affected by the reservoir of the Bolivar Dam on Sandy Creek.[24] Magnolia, Brewster and Zoar are other villages to receive adequate levee protection, with no moving required.[25]

The responsibility and cost of acquiring all land for such removals as well as that for acquiring the property, easements, and rights of way for the dams, reservoirs, levees, and various public utility, road, and other relocations fall upon the property owners of the District who are to receive flood control and other benefits. This total land cost has been estimated at $7,260,000, the largest amounts per county being in Tuscarawas ($1,934,570) and Coshocton ($1,058,174) Counties. The number of pieces of property listed as benefited or damaged had in 1937 reached 32,000. About 60,000 acres had already been acquired or contracted for by the District, notwithstanding delays due to litigation, etc.[26]

[23]The Daily Reporter, Dover, Ohio, May 18, 1937.

[24]Dover Quadrangle, Tuscarawas Co.

[25]It is reported that many residents of Zoarville now regret their decision to sell out individually and let the town be abandoned. Some of them and also certain farmers complain that their property was appraised only at present value, which is, they say, not enough for them to buy or build elsewhere on a rapidly rising market. The railroads, they say, got for their old property everything new, as ties, rails, bridges, etc., when they were relocated. Dover, Ohio, Daily Reporter, May 22, 1937.

[26]Mr. Hal Jenkins' Letter of May 3, 1937.

A proposed $1,500,000 issue of general property tax bonds was held unauthorized by the Fifth District Court of Appeals, as it was for recreation or conservation purposes, so the District is compelled for lack of funds to limit its activities to flood control. (M. W. C. D. News Release, April 29, 1938.)

The benefited properties are credited with about $14,000,000 increase in valuation, approximately twice the assessed damages. Thus the assessments on benefited property-owners would be about 50% of their increase in valuation. These assessments may be paid over a period of 30 years. Over 70% of this assessed benefit valuation is in the three river counties of Muskingum ($5,601,541), Tuscarawas ($3,049,324), and Washington ($1,211,909), in the order named.

Two million dollars has already been appropriated by the Ohio General Assembly towards the Conservancy District's share of the cost, and the Ohio State Highway Department and Federal Bureau of Public Roads are paying for all highway relocations (150 miles; estimated cost $8,804,753). The highway relocations were about 50% complete at the end of April, 1937.

The balance of the cost of this $43,000,000 project ($27,190,000: $22,090,000 granted by P.W.A. in 1933; an additional Federal grant of $3,500,000 in 1936; and $1,600,000 in February, 1937),[27] has all been contributed by the Federal Government, which through the United States Corps of Engineers is in charge of construction of all dams and public utility relocations. The public utility relocations include 13 miles of oil lines, 75 miles of gas pipe lines, 65 miles of power lines, and 270 miles of telephone and telegraph lines.

When construction (begun January, 1935) is completed (by June, 1938, it is expected) the United States Corps of Engineers will turn the entire project over to the District for operation and perpetual maintenance. One of the tangible benefits of the project to date has been the employment furnished. The first year it reached a peak of 4,000. During 1936 it averaged 4,500 weekly, with a peak of 5,178 one week. The average 1936 pay roll was $125,000 weekly. It was, of course, lower last year, as the work was more nearly completed.

May 14, 1937, at Cambridge, the people of the Zanesville-Cambridge section of the District celebrated the dedication of the Senecaville Dam (Plate VI, Fig. 21) just completed. It is 52 feet high and nearly half a mile long and is located nine miles southeast of Cambridge on the Seneca Fork of Wills

[27]This P.W.A. grant of $1,600,000 by Executive Order of the President, according to Mr. Bryce C. Browning, Secy.-Treas. of the District, meant that they could resume land purchases and yet keep their pledge to benefited property holders that their assessments would not be over $6,000,000. Ohio State Journal, Columbus, Ohio, February 18, 1937.

Creek. Its permanent lake (Fig. 24) then covering some 1,200 acres will be the largest in the Conservancy District, 3,550 acres, while its flood reservoir capacity will be 5,170 acres. This permanent lake will be larger than Buckeye Lake and exceeded in Ohio only by Indian Lake and St. Mary's. Seneca Fork's crooked valley traverses beautifully wooded hills and when filled, the lake will extend seven miles to Batesville in Noble County.

The benefits of this conservancy project cannot be measured in dollars alone.[28] While its main purpose is flood control and its second objective is water conservation, it also has for its ultimate goal proper land utilization, soil conservation, reforestation, wild life preservation, and better opportunities for outdoor life and recreation. Already there have been established within the District three demonstration projects for the prevention of soil erosion, a large tree nursery of the Soil Conservation Service near Zanesville, and at Coshocton a big laboratory for hydrologic, soil and water studies. This project, the government officials claim, has been located here because the results of the study can readily be utilized in the work of the Muskingum Conservancy District.

There some 25 or 30 persons, mostly scientists and engineers, will study soil and water losses from the complete Muskingum Watershed. Lysimeters (water meters) and various devices have been installed to chart the rain that falls, what soaks into the ground or runs off under different conditions of cover, soil, slope, terracing, etc.; to gauge stream flow; to observe silting. In short, for the first time to carry out a project on a scale broad enough to base definite conclusions. This may take four or five years but from the facts learned, it is hoped to determine proper soil and water conservation practices.[29]

Another project now established, throughout the Muskingum Basin under the direction of Dr. C. Warren Thornthwaite, Chief of the Physiographic and Climatic Research Division of the Soil Conservation Service, promises much aid to the Conservancy District. It has set up 500 stations throughout

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[28]Of the approximately $14,000,000 increase in property values originally listed as due to the District's flood control project, some $8,000,000 consisted of benefits to private and industrial property, over $2,760,000 benefits to public utility property and more than $3,200,000 of benefits to public property. *M. W. C. D. News Release* of Mar. 5, 1936. Sheet 2.

[29]Statement of Mr. W. D. Ellison, S. C. S. Hydraulic Engineer. *Columbus Dispatch,* March 21 and April 2, 1937.

the watershed where observers have taken readings at half hour intervals of rainfall, wind direction and velocity, and temperature. Daily maps covering the area will aid in the study of storms, their intensity, and their migrations. This should aid greatly in determining flood hazards.[30]

The Muskingum Project has already attracted much attention not only throughout the United States but also in Canada and in Europe. In March, 1937, nine members of the National House of Representatives flood control committee inspected the dams of the District, with a view to its possible importance as an example for other projects in the Ohio and Mississippi Valleys.[31]

Unlike the dams in the Miami Conservancy District in which the conduits are just large enough to permit sufficient water to go through to fill the stream channels below, with the excess water automatically backing up behind the dams, the Muskingum Dams, on account of the larger area and more complicated tributary system involved, will be controlled by steel gates operated by men directed from the Central Office which is in touch with all parts of the system. The conduits are larger than the channel capacities below, and as fast as the channels can accommodate the water after the passing of a flood crest one or more of the gates can be raised gradually, thus releasing water above the level of the permanent lake.

For facilitating water supply operations, seven of the dams have cast iron pipe lines imbedded in their concrete outlet works. Thus, without disturbing the structure, the District can easily connect with feeder lines, to furnish water from the permanent reservoirs for city, industrial or domestic use when needed.

During the January rains of 1937, on account of not yet owning all the necessary reservoir lands, the District could not close the gates at any of the dams, yet they automatically held back sufficient water to fill practically all of the reservoirs to permanent lake level or more, thus resulting in a lowering of flood crests from two to five feet and contributing to a lessened flood damage at critical points in the valleys below.[32] No flood

[30]Personal interview with Dr. Thornthwaite. Also information furnished by Mr. Hal Jenkins and Mr. Bryce C. Browning for the Amer. Forestry Association under date of Apr. 14, 1937.

[31]See *Ohio State Jour.*, Mar. 31, 1937.

[32]Estimates of C. C. Chambers, Chief Engineer for the Conservancy District. See also *Columbus Dispatch*, Jan. 24, 1937.

has come to test these great dams since the last one was finished early in February, 1938, but for flood control they are ready when the test does come.

ACKNOWLEDGMENTS

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OFFICIAL PLAN OF RESERVOIRS*

Name of Reservoir	Stream	Drainage Area Note (A) Sq. Mi.	Elevations		Area	
			Spillway El. Line Feet	Conser. Pool, Feet	Flood Reservoir Acres	Permanent Lake Acres
Wills Creek....	Wills Creek...	723	779	742	11,450	900
Senecaville.....	Seneca Fork...	121	842.5	832.2	5,170	3,550
Mohawk.......	Walhonding River.......	817	890	799.2	7,950	0
Pleasant Hill...	Clear Fork....	199	1,065	1,020	2,600	850
Charles Mill...	Black Fork....	216	1,020	977	6,050	1,350
Mohicanville...	Lake Fork....	269	963	932	8,800	0
Tappan........	Lt. Stillwater Creek.......	71	909	899.3	3,100	2,350
Clendening.....	Brushy Fork..	70	910.5	898	2,620	1,800
Piedmont......	Stillwater Cr..	84	924.6	913	3,200	2,270
Beach City.....	Sugar Creek...	300	976.5	948	6,150	420
Dover.........	Tuscarawas River.......	777	916	874	10,100	350
Bolivar........	Sandy Creek..	502	962	895	6,500	0
Atwood........	Indian Fork...	70	941	928	2,570	1,540
Leesville.......	McGuire Cr...	48	977.5	964	1,470	1,000
Totals.....	....	4,267	....	....	77,730	16,380

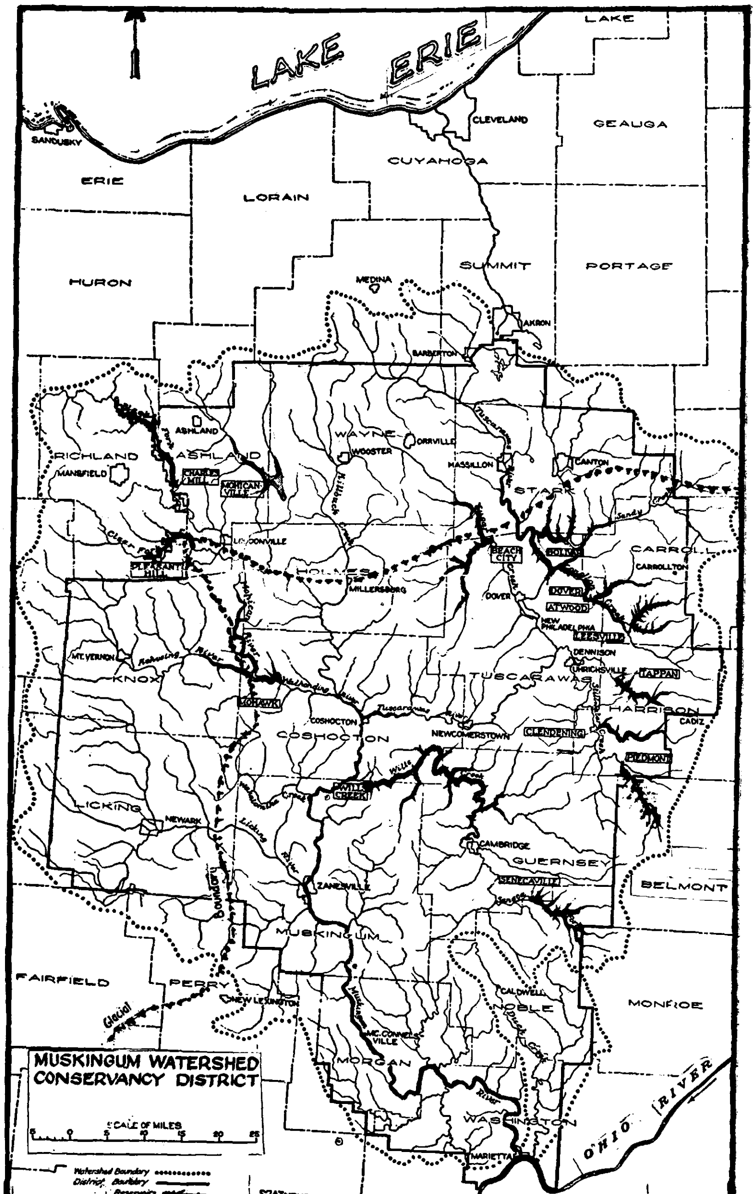
Note (A)—Less area reservoired above.

EFFECT OF OFFICIAL RESERVOIR PLAN ON MARCH, 1913, FLOOD*

Critical Point	Stream	Flood Stage, Ft.	Flood of 1913	Reduction, Feet
Walhonding River:				
Loudonville.....	Black Fork..........	....	....	6.0
Warsaw.........	Walhonding River...	....	....	10.7
Tuscarawas River:				
Sherrodsville....	Conotton Creek.....	....	....	— 1.0
Dover..........	Tuscarawas River...	7.0	16.1	7.8
N. Philadelphia.	Tuscarawas River...	....	....	7.1
Dennison........	Lt. Stillwater Creek.	....	....	(a)
Uhrichsville.....	Stillwater Creek.....	11.0	17.3	3.8
Tuscarawas.....	Tuscarawas River...	....	....	6.4
Gnadenhutten...	Tuscarawas River...	....	....	6.2
Port Washington	Tuscarawas River...	....	....	8.0
Newcomerstown	Tuscarawas River...	15.0	21.0	9.5
West Lafayette..	Tuscarawas River...	....	....	7.2
Freeport........	Stillwater Creek.....	....	....	4.0
Muskingum River:				
Coshocton......	Muskingum River...	8.0	28.8	10.6
Cambridge......	Wills Creek.........	....	....	3.7
Dresden.........	Muskingum River...	....	....	14.4
Zanesville.......	Muskingum River...	33.0	51.8	15.3
McConnelsville..	Muskingum River...	15.3	35.1	14.2
Marietta........	Muskingum River...	28.0	59.8	6.3

(a) Practically same as Uhrichsville.

*Compiled from the Official Plans for the Muskingum Watershed Conservancy District, Vol. I, Revised ed. of June 5, 1935.


LAKE ERIE
LAKE
SANDUSKY
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LORAIN
HURON
MEDINA
SUMMIT
PORTAGE
AKRON
BARBERTON
ASHLAND
RICHLAND
MANSFIELD
CHARLES MILL
MOHICAN-VILLE
WAYNE
WOOSTER
ORRVILLE
MASSILLON
CANTON
STARK
LOUDONVILLE
PLEASANT HILL
HOLMES
MILLERSBURG
BEACH CITY
BOLIVAR
CARROLL
CARROLLTON
DOVER
ATWOOD
NEW PHILADELPHIA
LEESVILLE
DENNISON
UHRICHSVILLE
TAPPAN
TUSCARAWAS
HARRISON
CADIZ
MT. VERNON
KNOX
MOHAWK
COSHOCTON
NEWCOMERSTOWN
CLENDENING
PIEDMONT
WILLS CREEK
LICKING
NEWARK
CAMBRIDGE
GUERNSEY
SENECAVILLE
BELMONT
ZANESVILLE
MUSKINGUM
FAIRFIELD
PERRY
NEW LEXINGTON
Glacial Boundary
CALDWELL
NOBLE
MONROE
MC CONNELSVILLE
MORGAN
WASHINGTON
MARIETTA
OHIO RIVER
ATHENS
MUSKINGUM WATERSHED
CONSERVANCY DISTRICT
SCALE OF MILES
0 5 10 15 20 25
Watershed Boundary
District Boundary
Reservoirs

EXPLANATION OF PLATE II

Fig. 2. Universal Potteries, Inc., South side of Cambridge (looking across Wills Creek Valley).

Fig. 3. Flood at Coshocton (looking north), August, 1935. Waterworks plant in center near bridges over Tuscarawas River. Glimpse of Walhonding at left. (These two rivers unite to form the Muskingum about a block southwest of the bridges.) Photo courtesy of Hal Jenkins.

Fig. 4. North end of Mohawk Dam (looking west upspream), Walhonding emerging from Twin tunnels. Photo by John Getz.

Fig. 5. Clendenning Spillway being cut through solid rock. (View westward into valley below. Dam is just to left of foreground.)


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EXPLANATION OF PLATE III

Fig. 6. Concrete Outlets of Wills Creek Dam. Gate house under construction above outlet. (Looking north downstream at part of valley below) September, 1936.

Fig. 7. Mohicanville Dam Spillway, gate guarded outlets and flood waters flowing into basin below. (Looking north upstream) January 27, 1937.

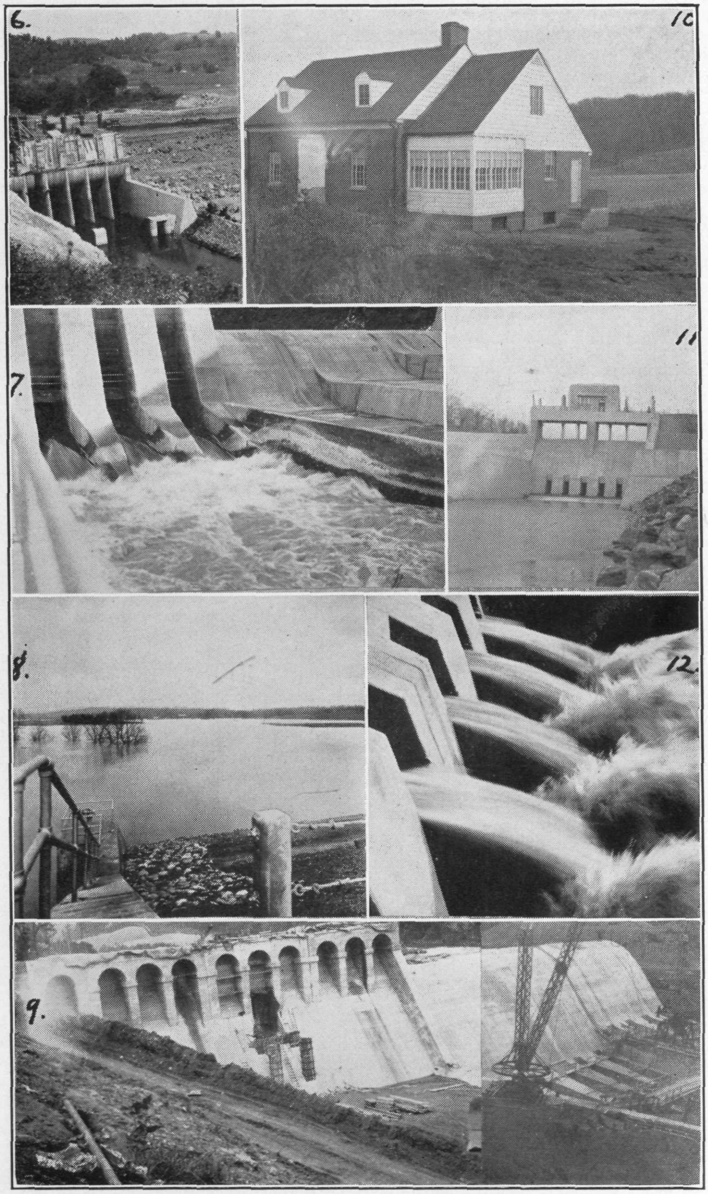
Fig. 8. Lake at Charles Mill Dam. Looking north from spillway. (Water surface about 6 feet above permanent lake surface.)

Fig. 9. Dover Dam seen from below. Outlets and stilling basin below at right. (Only west half of dam constructed then; nearly as much more to be added on the right.) Photo taken November, 1936.

Fig. 10. Gate operator's cottage, Mohicanville Dam. Part of dam visible in the background at the right. (Looking north upstream.)

Fig. 11. Charles Mill Spillway, Stilling Basin, Outlets, and Gatehouse above. (Looking upstream.)

Fig. 12. Charles Mill Dam. Outlets in action, January flood, 1937.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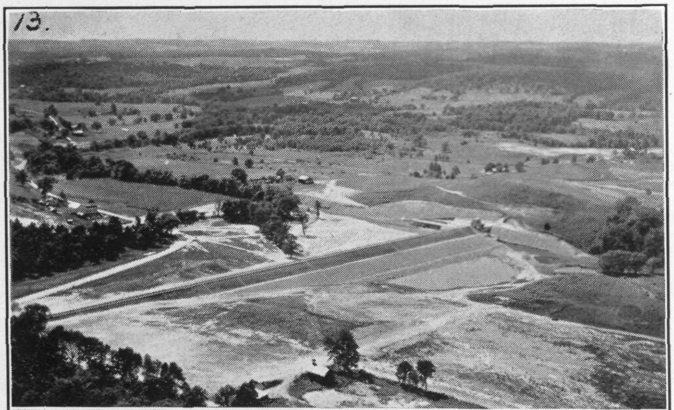
EXPLANATION OF PLATE IV

Fig. 13. Birdseye view of Charles Mill Dam and surrounding country. (Looking southwest downstream.) Note: Change in road to come around left end of dam on glacial terrace; school building in foreground to be abandoned; and spillway at foot of bed rock hill, which connects by a saddle of glacial drift to west wall of preglacial valley nearly a mile to the west.

Fig. 14. Site of Pleasant Hill Dam (looking northwest upstream). Dam 775 feet long and 113 feet high has since been constructed between the two temporary bridges, and extends from wooded cliff on left to wooded slope on right. Valley bottom here is 250 feet wide and its steep walls rise from the stream level of 964 feet to the rugged upland about 1,200 feet above sea level.

Fig. 15. Leesville Dam and part of Lake (looking west). Most of earthen dam is visible at the left, while at right above the concrete outlet works, the gate keeper's house may be seen. This photo and the two above, courtesy of Hal Jenkins, whose silhouette appears below. April, 1937.

Fig. 16. Village of Piedmont as seen from the dam. (Looking north downstream, September, 1936.)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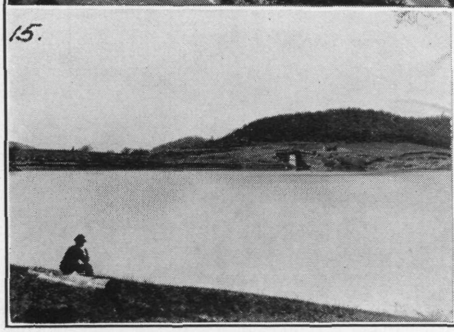
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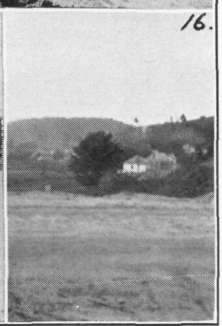
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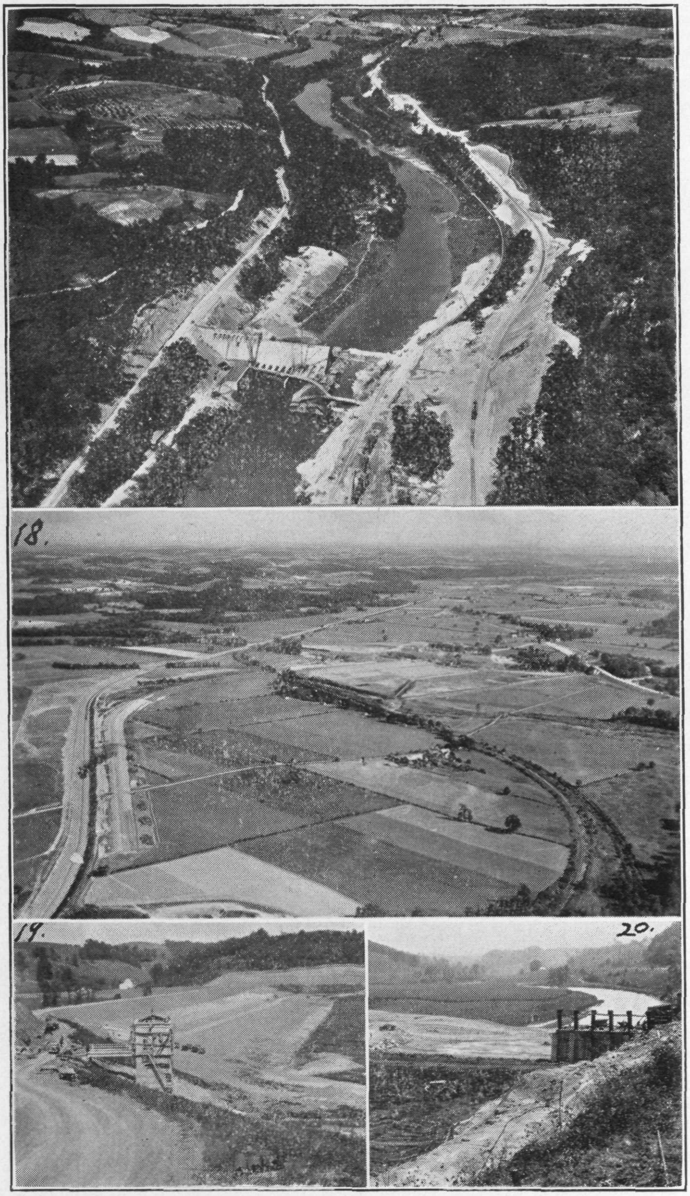
EXPLANATION OF PLATE V

Fig. 17. Dover Dam and the Gorge of the Tuscarawas River. (Looking north and upstream to village of Zoarville, soon to be abandoned.) Note: hillside orchards and farm lands separated by wooded ravines and slopes; State route No. 8 surmounting west abutment of dam; and new track of Penna. R. R. elevated from old line at right of stream.

Fig. 18. View of Beach City Dam and surrounding country. (Looking southeast downstream.) Long earthen dam in center; B. & O. R. R. moved from valley to terrace on left; roads and farms in mile-wide preglacial valley.

Fig. 19. Tappan Dam from above. (Looking north.) Gate house and dam have since been finished. State highway No. 250 elevated to height of north end of dam, which is 52 feet high and 1,600 feet long.

Fig. 20. Wills Creek Dam (under construction September, 1936). Looking upstream can be seen cornfield in valley at left of creek and on right close to stream, old road that had to be elevated to position above at right.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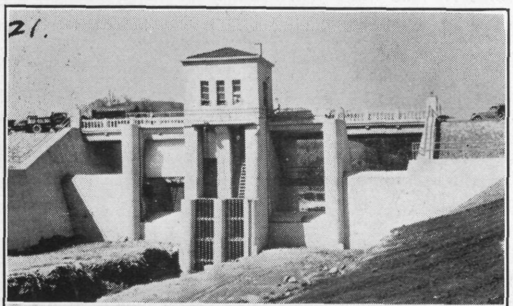

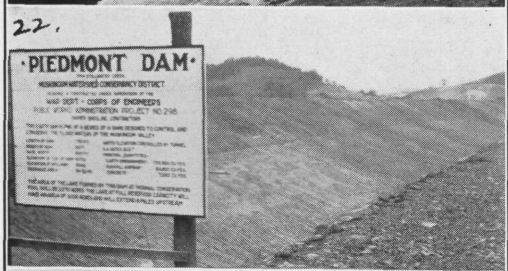

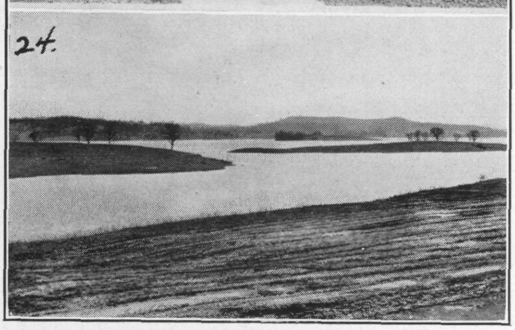

EXPLANATION OF PLATE VI

Fig. 21. Senecaville Dam (looking west to wooded slopes of valley below). Below are barred outlets whose heavy steel gates control level of permanent lake and flow of flood waters, by means of machinery operated by tender in gate house above. This dam was dedicated May 14, 1937.

Fig. 22. Piedmont Dam (lower side looking west). Below at right is part of the rock riprapping protecting lower half of the dam. Gate tender's cottage is seen at west end of dam.

Fig. 23. Piedmont Dam (looking north down U. S. Route 22, to be relocated to make way for permanent lake).

Fig. 24. Senecaville Lake (looking northeast from point near south end of dam) April, 1937. Lake then about 1,200 acres, to be increased to 3,550 acres.